INDIANA DEPARTMENT OF TRANSPORTATION
OFFICE OF MATERIALS MANAGEMENT

MEASUREMENT OF RETROREFLECTIVE PAVEMENT MARKING MATERIALS ITM No. 931-07T

1.0 SCOPE.

1.1 This procedure covers the measurement and acceptance of retroreflectivity on pavement markings using portable hand-operated instruments.

1.2 The purpose of this test method is to assure that adequate retroreflectivity of horizontal pavement markings is provided by newly applied markings for the driver of a vehicle.

1.3 Newly applied pavement markings are those which have been applied between 14 to 30 days before testing and from which all excess glass spheres have been removed. Excess glass spheres contribute to erroneous readings directly after application and are generally not present a few days after application.

1.4 The coefficient of variation allows the Department to determine whether the marking shall be reapplied even if the average exceeds the minimum requirements. A coefficient of variation greater than 30% indicates that the appearance of the marking will be non-uniform and may cause problems for the nighttime visibility of the driver.

1.5 The values stated in either acceptable English units or SI metric units are to be regarded separately as standard, as appropriate for a specification with which this ITM is used. Within the text, SI metric units are shown in parenthesis. The values stated in each system may not be exact equivalents; therefore, each system will be used independently of each other, without combining values in any way.

1.6 This procedure may involve hazardous materials, operations, and equipment, and may not address all of the safety problems associated with the use of the ITM. The ITM user should follow appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

2.0 REFERENCES.

2.1 ASTM Standards

E 1710 Standard Test Method for Measurement of Retroreflective Pavement Marking Materials with CEN-prescribed Geometry Using a Portable Retroreflectometer

2.2 ITM Standards

802 Random Sampling

3.0 TERMINOLOGY.

3.1 Terms and Abbreviations. Definitions for terms and abbreviations will be in accordance with the, Section 101 of the Department's Standard Specifications and the following:

3.2 Section. The application of each color of pavement marking completed by one application crew in one day.

3.3 Segment. A portion equal to one fifth of the pavement marking application of a day.

3.4 Sampling Zone. A location within each segment that retroreflectivity readings are taken.

3.5 CEN Geometry. The geometry of instrument measurement specified by CEN, based on a viewing distance of 30m from an arbitrary passenger vehicle with an eye height of 1.2m and a single headlight mounting height of 0.65m in the same vertical plane and a pavement stripe directly ahead of the headlight.

3.6 Retroreflectivity. A standard of measure for pavement markings. The units for these measurements are millicandelas per square meter per lux.

4.0 SIGNIFICANCE AND USE. The test method is used to determine retroreflective properties of horizontal pavement marking materials containing retroreflecting beads, such as traffic stripes and surface symbols, using a portable retroreflectometer that may be placed on the road delineation to measure the retroreflection at a prescribed geometry.

5.0 APPARATUS.

5.1 Retroreflectometer in accordance with ASTM D 1710, Delta Model LTL 2000 or LTLX. The measurement geometry used will be 88.76° for the entrance angle β_1, 0° for β_2, and 1.05° for the observation angle. The aperture angles for both the source and receiver will not exceed 0.33°.

A factory calibration shall be performed on the retroreflectometer at a minimum of once per calendar year.

6.0 SAMPLING. Each sampling zone for retroreflectivity measurement will be determined as follows:

6.1 Longitudinal Lines.

6.1.1 Divide the number of miles of each color of pavement marking application completed in a single day work by five to establish the length of each segment containing a sampling zone.

6.1.2 In three random segments, the Engineer will randomly generate a point to the nearest tenth of a mile to begin taking measurements of the sampling zone area in accordance with ITM 802.

6.2 Letters, Symbols, and Transverse Lines.

6.2.1 Each letter, symbol, or transverse line is considered a sampling zone area.

7.0 PROCEDURE.

7.1 Use the manufacturer's instructions for operation of the retroreflectometer.

7.1.1 Ambient temperature shall be not less than 40°F (4°C).

7.1.2 The surface of the marking shall be clean and dry.

7.1.3 Transporting the instrument from an air conditioned area to the test site may result in fogging of mirrors in the instrument. If there is any doubt concerning the calibration or the readings are not constant, allow the instrument to reach ambient conditions and recalibrate with the instrument standard.

7.1.4 Turn on the retroreflectometer, and allow the device to reach equilibrium following the manufacturer's instructions.

7.1.5 Subsequent to standardization, an internal or secondary reference surface such as diffuse white or retroreflecting surface is used to maintain the standardization of the instrument during brief periods of transport to the test site area.

7.2 Zero and calibrate the hand-operated instrument. Print the zero and calibration readings at the beginning of the days work. Recalibrate the instrument every 2h when taking readings. Print the zero and calibration readings each time these operations are performed. The instrument zero and calibration are to be in accordance with the instrument manufacturers written instructions.

7.3 All measurements obtained in the sampling areas listed as follows will be made in the direction of traffic flow. On the centerline of two-lane roads, the required number of measurements will be made for each line in each direction of the single and double centerlines.

7.4 Longitudinal Lines.

7.4.1 Make 20 retroreflectivity measurements within each sampling zone of each longitudinal line. Make the first measurement exactly at the beginning of the sampling zone. Take subsequent measurements at approximately 15ft intervals. If any portion of the sampling zone is unsafe for taking measurements, then move forward to the first point which may be inspected safely and begin the sampling zone there. Do not move the sampling zone simply for convenience. A change in the starting point of one sampling zone should not change the starting points of any subsequent sampling zone. If a valid measurement is not attainable at a location within the sampling zone due to a pothole, grass, obvious tracking, etc., move forward in the sampling zone to the first available location for a valid measurement, then resume the subsequent measurements within that sampling zone in the incremental procedure described above. For measurements taken on centerlines, take alternating readings between solid lines or on the combination of solid and skip lines.

7.4.2 When a sampling zone contains only skip lines for evaluation. Measure each skip line at two evenly spaced locations on the line. Continue measuring within the established sampling zone in this manner until 20 readings are obtained.

7.5 Letters, Symbols and Transverse Lines.

7.5.1 A minimum of ten random measurements will be made on each letter, symbol, or transverse lines which are 8ft (2.4m) tall or wide. A minimum of five random measurements on each letter, symbol, or transverse lines smaller than 8ft (2.4m) will be made.

8.0 CALCULATIONS

8.1 Calculate the average, standard deviation and coefficient of variation for each sampling zone, segment, and section as follows:

Average ($\bar{x}$):

$$\bar{x} = \sum_{i=1}^{n} \frac{x_i}{n}$$

Standard Deviation (s):

$$s = \sqrt{\frac{\sum_{i=1}^{n} (x_i - \bar{x})^2}{n-1}}$$

Coefficient of Variation = ($s / \bar{x}$) x 100

Where:

n = the number of measurements within each measurement sampling zone

9.0 REPORT. The report shall include the following items :

9.1 Test date and time.

9.2 Date and time of application of the pavement marking.

9.3 Color of and type of pavement marking.

9.4 Manufacture and product name or number of each material used.

9.5 The location road, route number, reference points, direction of traffic, line identification, and other designated information.

9.6 All measurements reported in millicandelas per square meter per lux for each sampling zone of each traffic direction for each longitudinal lane marking or each letter, symbol, and transverse line

9.7 The average and coefficient of variation of the measurements for each sampling zone, segment, and section

9.8 The serial number and date of last factory calibration for the retroreflectometer.

9.9 Each of the zero and calibration readings.

10.0 ACCEPTANCE CRITERIA

10.1 Longitudinal Lines.

10.1.1 When 18 of the individual measurements and the average in a sampling zone meet or exceed the required minimum retroreflectivity values for the pavement marking materials which are being measured, the segment that is being evaluated will be accepted.

10.1.2 When more than 5 of the 20 measurements taken within a sampling zone fail to meet the minimum retroreflectivity requirements established for the pavement markings which are being measured, the segment is not accepted and additional testing within that segment is not required.

10.1.3 If less than 18 and more than 15 of the individual measurements within a sampling zone meet or exceed the required minimum retroreflectivity values established for the pavement markings which are being measured, additional measurements will be taken within the segment that is being evaluated.

When additional measurements are required, the Engineer will randomly establish two new sampling zones within the segment in question using the procedure detailed in 6.1.2. Obtain measurements for each of these sampling zones as described in 7.1 to 7.4.2. These measurements will be combined with the initial measurements for evaluation of the segment. If less than 54 of the 60 measurements, 20 in each of three sampling zones, or the average taken within a segment fail to meet the minimum retroreflectivity requirements established for the pavement markings which are being measured, the segment is not accepted.

10.1.4 When more than one of five segments is not accepted on a section of longitudinal pavement marking, the entire section of pavement markings will not be accepted.

10.1.5 When the coefficient of variation is greater than 30% for any sampling zone, segment, or section, the entire section of pavement marking will not be accepted.

10.2 Letters, Symbols, and Transverse Lines.

10.2.1 When 90% of the readings in a sampling zone meet or exceed the required minimum retroreflectivity values and the average of the sampling zone meets or exceeds the retroreflectivity values established for the pavement marking materials that are being measured, the letter, symbol or transverse line which is being evaluated will be accepted.

10.2.2 When more than 25% of the individual measurements taken within a sampling zone fail to meet the minimum retroreflectivity established for each of the letters, symbols, or transverse lines which are being measured, the letter, symbol, or transverse marking will not be accepted and additional measurements are not required.

10.2.3 If less than 90% but more than 75% of the individual measurements taken within a sampling zone fail to meet the minimum retroreflectivity requirements for each of the letters, symbols, or transverse markings which are being measured, the letter, symbol, or transverse line and additional measurements will be taken within the sampling zone that is being evaluated.

When additional measurements are required, randomly take twice the number of measurements as required in 7.5.1 on each letter, symbol or transverse line. These measurements are to be combined with the initial measurements for each letter, symbol, or transverse line. If less than 90% of the total combined individual measurements or the average of all measurements for each of the markings taken within a sampling zone fails to meet the minimum retroreflectivity requirements established for the letter, symbol, or transverse line which are being measured, the pavement marking is not accepted.

10.2.4 When the coefficient of variation is greater than 30% for any letter, symbol, or transverse line, the specific letter, symbol, or transverse line will not be accepted.